onto a strong, isolated line at 7139.1 centimeters (cm),$^{-1}$ while for altitudes typically below 6 km the laser wavelength is locked onto a weaker line at 7133.9 cm^{-1}. By normalizing the laser differential absorption signal with the laser power signal, the $H_2O(v)$ measurement is unaffected by clouds, haze, plumes, etc., thereby enabling high spatial resolution measurements in and around clouds. The $H_2O(v)$ mixing ratio is computed by an algorithm from the differential absorption magnitude, ambient pressure and temperature, and coefficients derived from laboratory calibration of the sensor. These calibrations are conducted prior to each field mission, and they involve measuring the sensor response to known $H_2O(v)$ concentrations flowing through a 3 meter-long chamber at pressures ranging from 100 to 1000 hecto Pascals. Glen Sachse, NASA Langley Research Center, collaborated with the investigator on this study.

Point of Contact: James Podolske
(650) 604-4853,
jpodolske@mail.arc.nasa.gov

The Argus Instrument

Max Loewenstein, Hansjürg Jost, James Podolske, Jeff Greenblatt

The Argus instrument is a lightweight, infrared (3- to 5-micrometer wavelength) diode-laser spectrometer. It was designed for measuring the atmospheric nitrous oxide (N_2O) and methane (CH_4) tracer fields in situ from balloons and aircraft. The instrument can return atmospheric measurements over the altitude range of 5 to 30 kilometers (km).

In preparation for the winter 1999-2000 SAGE III Ozone Loss and Validation Experiment/ Third European Stratospheric Experiment On Ozone (SOLVE/THESEO 2000) Arctic ozone campaign, Argus was integrated on the ER-2 high-altitude research aircraft during the summer and fall of 1999. Thermal calculations and engineering modifications of Argus were undertaken at Dryden Flight Research Center (DFRC), home of the ER-2, for the successful completion of this task, which also required several test flights to tune up the thermal conditioning system of the instrument. Several Argus improvements were also made to enhance data quality for this mission. These included installing a longer optical-path gas sampling cell, improving laser temperature control, streaming the data analysis code, and adding an in-flight gas calibration system.

The ER-2 component of the SOLVE/THESEO 2000 Arctic ozone study began in January of 2000 with ferry flights from DFRC through Westover Air Force Base, Massachusetts, and then to Kiruna, Sweden, at 67° N. In 12 flights originating in Kiruna, from January through March of 2000, regions both inside and outside the winter polar vortex were sampled by the instruments onboard the ER-2. The research was supported by additional aircraft-, balloon- and ground-based instruments from both the NASA SOLVE and European THESEO elements of the field campaign. The overall purpose of the campaign was to achieve a detailed understanding of the chemistry and the spatial extent and intensity of ozone loss inside the winter polar vortex. Polar Stratospheric Clouds (PSCs) that form during the cold Arctic polar night in the lower (10 to 20 kilometers (km)) stratosphere greatly enhance destruction of ozone by human-caused emissions of chlorine and bromine. The presence of these PSCs is fundamental to the formation of the well-known Antarctic ozone hole, though the amount of Arctic ozone destruction is not as great as that observed annually in the early austral spring over the Antarctic.

The Argus instrument specifically contributed to SOLVE by measuring the long-lived chemicals N_2O and CH_4, which act as dynamical tracers of the vortex motion. Two aspects of vortex dynamics are of importance: subsidence of the vortex due to strong radiation cooling in the polar night, and formation of a vortex edge marking the boundary between the subsiding region and the midlatitude atmosphere, defined by the strong circumpolar wind jet enclosing and isolating the polar night region. The N_2O and CH_4 tracers move, chemically unmodified, with the atmospheric motion, thus acting as constant metrics against which to measure ozone destruction activity in moving air masses. Several other instruments on the ER-2 and on balloons launched during the campaign period measure the same tracers as Argus, reflecting the great importance of knowing the tracer fields accurately.

On the ER-2 the Argus instrument is the smallest and lightest of four instruments that measure tracers by using different measurement principles. In order to validate tracer measurements, the four ER-2 instruments entered into a detailed intercomparison of their N_2O measurement results on all ER-2 flights. N_2O plays a special role as a tracer because of its very long (greater than 100 years) atmospheric lifetime. A result of this effort was to merge three of the N_2O datasets into a "unified" dataset formed by performing a weighted average of the three sets. The fourth set of much lower data rate, but of the highest accuracy, was used as a quality check on the unified set. This set, recorded on the SOLVE data archive, then became the canonical N_2O tracer set for use by other experiments on the ER-2, such as integrating measured total inorganic chlorine into a Cl: N_2O rule. N_2O, an easier measurement than chlorine, could then be used to infer total chlorine at other times and locations in the stratosphere.

A postmission workshop was held in Palermo, Italy, in September 2000, where project personnel presented papers and posters. Papers have been submitted for publication with such topics as the unified N_2O data set, vortex subsidence, vortex edge detection, formation of unusually large, rapidly sedimenting PSC particles, ozone loss quantified at 16% over the Arctic stratosphere, and an unprecedented local loss of ozone of 60% at 18-km altitude. Jeff Grose, San Jose State University Foundation, and Margaret Swisher, Foothill/DeAnza Community College District, collaborated with the Ames investigators on this project.

Point of Contact: Max Loewenstein
(650) 604-5504
mloewenstein@mail.arc.nasa.gov